

OKLAHOMA SPACE ALLIANCE

OUTREACH – January 2019

102 W. Linn #1, Norman, OK 73069

Oklahoma Space Alliance will meet
2:00 p.m. on January 12, 2019
at Zio's Italian Restaurant in Norman, Oklahoma.

Directions are inside.

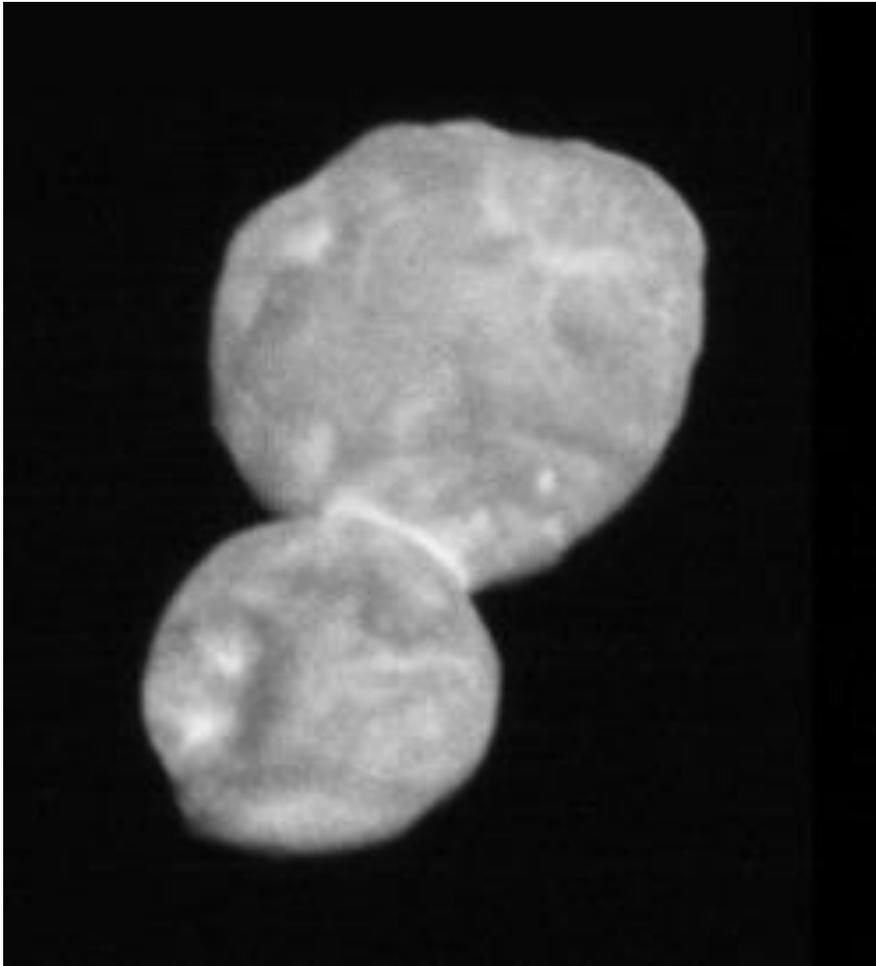


Figure 1 Ultima Thule as seen by New Horizons (NASA Photo)

OKLAHOMA SPACE ALLIANCE OUTREACH January 2019

January Meeting:

Oklahoma Space Alliance chapter of National Space Society will meet at 2:00 p.m. on January 12, 2019 at Zio's Italian Restaurant in Norman, Oklahoma.

Saturday January 12, 2019

Program

Place: Zio's Italian Restaurant

1353 24th Ave NW

Norman, Oklahoma

2:00 PM

- 1) Our meeting is now Zio's Italian restaurant, Our previous meeting spot, Earls Rib Palace, closed its doors unexpectedly in late October.
- 2) What's happening in Space
- 3) Oklahoma Space Alliance Chapter Business Discussion
 - a. Review OSA treasure's report
 - ~~b.~~ Summary of December meeting minutes
 - c. New officers of Officers for 2019 are:

President	Cliff McMurray
Vice President	David Sheely
Secretary	Sydney Henderson
Treasurer	Tim Scott

- 4) Chatting, networking and video

Minutes of December Party

Oklahoma Space Alliance had its annual holiday party on December 15 at the Koszoru's house. Attending were Tom and Heidi Koszoru, Russ Davoren, Mike Hopkins, Prithviraj Kadiyala, Clifford and Claire McMurray, Dave Sheely, Steve and Karen Swift, Brian Swift, Bhagyashree Waghule and Syd Henderson. This was Prithviraj and Bhagyashree's first meeting.

We had a brief meeting at which we had elections. Oklahoma Space Alliance officers for 2019 are Clifford McMurray, President; Dave Sheely, Vice President; Syd Henderson, Secretary, and Tim Scott, Treasurer. Outgoing OSA President Dave Sheely presided until the election, and incoming President Clifford McMurray afterward.

Bhagyashree is working on the effects of low gravity on space travelers and we talked about her researches.

--Minutes by OSA Secretary Syd Henderson

Space News

On January 3, the Chinese National Space Agency's *Chang'e 4* space lander made the first soft landing by any spacecraft on the far side of the Moon. Shortly after, it released the Yutu-2 ("Jade Rabbit 2") lunar rover. The landing site is in the Von Karman crater in the South Pole-Aitkin Basin. This doesn't mean, however, that *Chang'e 4* landed near the

Lunar South Pole. The Basin is 1500 miles in diameter and the landing site is near the north end, 45 degrees from the Lunar South Pole.

In addition to the lander and rover (and orbiter, which seems to be forgotten), which were launched on December 7, the *Chang'e* mission includes a relay satellite, *Queqiao*, which was launched last May and is in a wide halo orbit around the Earth-Moon L2 point, the Lagrange point above the far side of the Moon. This enables it to receive signals from both Earth and *Chang'e 4*.

In addition to the lunar exploration, *Chang'e 4* carries silkworms and plants to see how they grow in lunar gravity. It's also doing some radio astronomy since it is blocked from all radio signals from Earth except those relayed through *Queqiao*.



Figure 2 China's lunar rover Yutu 2 (Jade Rabbit 2) photographed by the Chang'e 4 lander (Chinese National Space Agency)

This is going to be an unusually active year for lunar exploration. Next up looks to be *Beresheet* (Genesis—formerly “Sparrow”), created by the Israeli company SpaceIL for the Lunar X-Prize (which has expired) which will be launched by SpaceX on February 13. (More on this at the meeting).

Since *Beresheet* will take over two months to get to the Moon, India's *Chandrayaan-2* will likely beat it there. Like *Chang'e 4*, *Chandrayaan-2* will land in the Lunar South Polar region, but on the near side of the Moon (and not in a basin) and at 70 degrees South. This mission consists of a lander and a rover. The orbiter will relay communications.

Several other former Google Lunar X-Prize contestants are also hoping to make it to the Moon, but these seem more speculative. *ALINA*, the Autonomous Landing and Navigation Module, is the brainchild of the German based group PTScientists. The mission would consist of a lander and two small rovers. The rovers were developed by Audi and are called Audi Lunar Quattro. I believe the “Quattro” refers to them having four wheels. The plan is land the rovers near the *Apollo 17* landing site in the Taurus-Littrow valley in the Lunar highlands. *ALINA* is on SpaceX's launch schedule for the third quarter on 2019.

Moon Express is planning to launch its *Lunar Scout* in the fourth quarter of 2019 on Rocket Lab's Electron launch vehicle from New Zealand. This will land near the Moon's South Pole and include a telescope to be placed on the three-mile high Malapert Mountain. There's also a chance the *Lunar Outpost MX-3* lander will also make it to the Moon's South Pole this year. That one will be looking for water. Moon Express is planning a sample return mission in 2019.

NASA apparently has confidence in Moon Express. On November 29, they were awarded a Commercial Lunar Payload Services contract along with eight other companies.

TeamIndus is a private company based in Bangalore, India. Their plan is to land a lander (HHK1) and rover (ECA, or "A Small Hope") I'm most skeptical about this one, since they haven't got a launch contract and don't appear to be as well-financed as PTScientists or Moon Express. They also haven't set a landing place.

Finally, China has scheduled its *Chang'e 5* lunar sample return mission for launch in December 2019. This will be the first lunar sample return mission by anybody since Russia's *Luna 24* in 1976. The mission apparently doesn't include a rover but does include a remote docking with the return module. Apparently, *Luna 24* landed directly on the Moon and released the sample capsule on its return.

South Korea has shown restraint and won't launch its lunar mission until 2020. The Korea Pathfinder Lunar Orbiter mission will also include an impactor, hopefully not into one of the other countries' landers.

This year's moon missions are sort of a prelude to the large number of Mars missions planned for 2020. These include the United Arab Emirates' probe *Hope*, NASA's *Mars 2020* space rover (which still doesn't have an official name), China's Mars Global Remote Sensing Orbiter, Lander and Small Rover, and ESA's *ExoMars Mars Rover*, and possibly *Japan's Mars Terahertz Microsatellite*. all scheduled to be launched in July 2020.

At 11:33 p.m. (Central Daylight Time) on December 31, *New Horizons* made its long-awaited flyby of the Kuiper Belt Object 2014 MU69. (It was January 1 in London and at Cape Canaveral, so that's the date you'll usually see.) Since 2014 MU69 is the farthest and coldest object to receive a visit by a spacecraft, it was nicknamed Ultima Thule after the farthest northern place known to the ancient Romans.

Ultima Thule appears to be made up of two smaller objects that collided and stuck together (see cover). It also appears to have a reddish tinge. It is about 19 miles long, and the two parts are 12 and 9 miles. The two parts are now dubbed Ultima and Thule.

Ultima Thule is currently about 4.1 billion miles from Earth; in other words, over a billion miles farther out than Pluto. From that distance, it takes six hours for light to reach Earth. Transmission speed is also slow, so we didn't start getting good pictures until late morning. We should eventually get pictures with a resolution as fine as 100 feet, but those may be months away.

NASA is searching for another target to visit, which raises the question: What is farther than Ultima Thule?

The Transiting Exoplanet Survey Satellite (TESS) is still near the beginning of its mission and has detected some 200 exoplanets. The discovery of one of the most remarkable of these was announced on January 7. HD 21747b orbits a K4.5 type dwarf (an orange dwarf) about 50 light-years away, with an orbital period of 35.6 days, which leads to an estimated temperature about three hundred degrees Fahrenheit. Its diameter is about 2.84 times that of Earth (measured by TESS). You'd expect a planet like this to be largely gas. What is remarkable is that it has a mass 23 times that of Earth, which means its density is almost exactly that of Earth, which is six times that of water. This indicates that HD 21747b must be mostly rock and iron, and if there is a thick atmosphere, it must be really dense. (Diana Dragonir, the leader of the team who discovered the exoplanet, says it likely has the density of water, but that contradicts her measurements.) Abstract is online at <https://arxiv.org/pdf/1901.00051.pdf>.

Astronomers led by Alfred Tiley at Durham University in the United Kingdom appear to have found the "missing" dark matter from the early Universe. It turns out that it was right where it is now, in galaxies. (Earlier studies appeared to show there was less dark matter in early galaxies, and this study contradicts them.)

Apollo Anniversaries

We are now well into the 50th anniversary of the Apollo missions that preceded the July 20, 1969 moon landing by Neil Armstrong and Buzz Aldrin. The most famous of these was the *Apollo 8* mission on December 21 – 27, 1968, which was the first flight on which a manned spacecraft orbited a celestial body other than Earth. On Christmas Eve, the crew made a broadcast from lunar orbit which was the most watched television program until that time. The crew famously read the first ten verses of *Genesis*. After all the turmoil of 1968, *Time* magazine decided to end the year on a note of hope and named Frank Borman, James Lovell and William Anders their men of the year. Borman was on his second and last spaceflight and was mission Commander. Anders was on his only spaceflight and was Lunar Module Pilot despite there being no Lunar Module on this flight. James Lovell was Command Module Pilot and on his third spaceflight, and would fly to the Moon again on another famous flight, which was *Apollo 13*, so he didn't get to land on the Moon then, either.

The backup crew on this mission is notable as well: they were Neil Armstrong, Buzz Aldrin, and Fred Haise. Haise was the Lunar Module Pilot for *Apollo 13*. The other two are more famous.

Apollo 9 is, along with *Apollo 7*, the least remembered of these early missions. It was the first human test of the lunar module, but never left Earth orbit. They did get to test docking with the lunar module and maneuver with it, which made this one of the longest *Apollo* flights, lasting from March 3 through 13, 1969. The Commander was James McDivitt on his second and last flight. David Scott was Command Module Pilot, but is better known as commander of *Apollo 15* and the seventh man to walk on the Moon. The Lunar Module Pilot was Rusty Schweickart on his only spaceflight. Schweickart had earlier been on the background crew to *Apollo 1*. He had problems with space sickness on *Apollo 9*, which is why he didn't fly again.

Incidentally, since the Command Module and LEM were being flown as separate vehicles, both vehicles got names. The Command Module was *Gumdrop* and the LEM was named *Spider*.

Coincidentally, the *Apollo 8* and *Apollo 9* missions are the only Apollo missions all of whose crew members are still alive.

Sky Viewing

On the night of January 20 – 21, there will be a perfectly American lunar eclipse. That is, it will be visible in its entirety over all North and South America, with the peak of the eclipse occurring around midnight on the east coast of North America and the west coast of South America. The only other parts of continents to see it in its entirety the northwestern fringe of Europe, and the northern coast of eastern Siberia. Hawaii, on the other hand, misses the beginning of the partial phase. The main events are (in Central Standard Time)

Partial eclipse begins:	9:34 p.m.
Total eclipse begins:	10:41 p.m.
Total eclipse ends:	11:44 p.m.
Partial eclipse ends:	12:51 a.m.

Because the side of Earth facing the Moon see the eclipse at the same time, these times are valid for the entire Central Time Zone and need only be adjusted for time zone where the eclipse is visible.

This is an unusual eclipse in another way: The Moon is at perigee shortly after noon on January 21, so this is a so-called “supermoon”, with the Sun, Earth and Moon lined up; (obviously, since otherwise there wouldn't be a lunar eclipse). Furthermore, this is a close perigee (perigees differ by about 10,000 miles). These factors mean that the Moon appears about as big as it can get. On the other hand, the Earth was at perihelion on January 3, so the Sun also appears nearly as big as it can get (in the daytime, naturally). Total lunar eclipses should be less common when the Moon is at perigee since there's a better chance part of the Moon will be outside the umbral shadow of the Earth. But the Sun being closer makes the Earth's shadow bigger and the Moon is deeper in the umbra, so two effects cancel each other out to a certain extent.

Mercury is currently too low at Sunrise to be visible and will be in superior conjunction at the end of January. However, Mercury becomes much more visible in the second half of February when it sets ninety minutes after the Sun and will still be ten degrees above the horizon forty-five minutes after sunset.

Venus, on the other hand, is rising about two hours and is near maximum brightness at magnitude -4.6. (If your curious, it's in Libra, but will move through Scorpius, Ophiuchus and Sagittarius on its way to Capricornus in late February.) On the way it has a conjunction with **Jupiter** in mid-January, with a minimum separation of 2.5 degrees on January 22, and a conjunction with **Saturn** in mid-February with a minimum separation of 1.1 degrees on February 18. By then Venus and Saturn will be pretty low in the eastern sky at the beginning of dawn twilight but should still be easily visible.

Mars is still visible in the southwest after sunset, but is also dimming so that it's magnitude 0.5. Still, it's setting at 11:00 p.m. and is the only visible planet in the evening sky. Mars is currently in Pisces and doesn't move into Aries until February 12. By then it will have faded to magnitude 1.0.

Jupiter is magnitude -1.8 and shines brightly below Venus in the morning sky, Jupiter is rising earlier each morning as it approaches the conjunction with Venus. Jupiter will be rising about 4:00 a.m. by February 1, and 2:30 a.m. by February 28. Jupiter is currently located in Ophiuchus.

Saturn was in conjunction with the Sun on January 2, so won't be visible for most of January. However, by the end on January it will be rising about 90 minutes after sunrise, and by February 28 will be rising two and a half hours before the Sun. During all this time, it is about magnitude 0.6.

Uranus is still findable in the south after dark and will still be visible (probably with binoculars) in the southwest through February. It is near the border of Pisces and Aries, which Mars is approaching, and the two planets have a conjunction in mid-February. Uranus will be about one degree south by southeast of Mars on February 12, and one degree due south of Mars on February 13.

Neptune is in Aquarius in the southwest after sunset and is getting harder to find even with a telescope. It will become completely lost in twilight by mid-February as it approaches a March 6 conjunction with the Sun.

[Finder charts for Uranus and Neptune are online at wwwcdn.skyandtelescope.com/wp-content/uploads/WEB_UrNep18.pdf.]

Information for this section comes from the January and February issues of *Sky & Telescope* and *Astronomy*, and from their websites.

Viewing Opportunities for Satellites (January 12 – February 12)

You can get sighting information at www.heavens-above.com, which allows you to get satellite-viewing data for 10-day periods and gives you a constellation map showing the trajectory of the satellite.

<https://spaceflight.nasa.gov/realdata/sightings/SSapplications/Post/JavaSSOP/JavaSSOP.html> gives coordinates at 20-second intervals from when the satellite rises, not from when it peaks. (This program requires Java. I'm currently using Internet Explorer to run it and making an exception for the site in the Java Control Panel.) I'm using its information for the International Space Station and Hubble Space Telescope, interpolating when necessary. It doesn't give you information for Tiangong 2, so I'm using Heavens Above for those. The *Sky & Telescope* web site carries ISS observation times for the next few nights at skyandtelescope.com/observing/almanac.

With the addition of the solar panels, the International Space Station can be as bright as magnitude -3.8, which it will on March 18, making it brighter than all the stars other than the Sun and all the planets other than Venus, although magnitude -2 to -3 is more likely. The Hubble Space Telescope can get up to magnitude 1.5, which is brighter than the stars in the Big Dipper, although, since it is lower in the sky, it is more difficult to see. I'm including data for Tiangong 2, which can get up to magnitude 1.0 at least.

Missions to and from the International Space Station or Tiangong-2 may change its orbit. The only launch to either station during this time period is the uncrewed SpaceX Demonstration Mission #1 to the ISS on January 17.

ISS, 11 January 2019			ISS, 13 January 2019		
Time	Position	Elevation	Time	Position	Elevation
6:38 a.m.	324°	21°	Appears from Earth's shadow		
6:39	337	39	6:30:51 a.m.	282°	25°
6:40	39	62	6:31:17	272	32
6:41	104	39	6:32	227	43
6:42	117	21	6:33	181	32
			6:34	163	19

Tiangong-2, 15 January 2019

Time	Position	Elevation
6:37 a.m.	243°	14°
6:40	333	89
6:43	63	10*

ISS, 22 January 2019

Time	Position	Elevation
6:36 p.m.	214°	21°
6:37	202	40
6:38	135	66
6:39	68	39
6:40	57	21

Tiangong-2, 26 January 2019

Time	Position	Elevation
7:06 a.m.	292°	10°
7:09	210	66
7:12	127	10*

Passes 7° above Venus and Jupiter

Tiangong-2, 8 February 2019

Time	Position	Elevation
6:55 p.m.	230°	10°
6:58	150	60
7:00	74	20

Vanishes into Earth's shadow

ISS, 9 February 2019

Time	Position	Elevation
7:19 p.m.	301°	21°
7:20	291	40
7:21	224	66
7:22	158	40
7:23	146	21

HST, 9 February 2019

Time	Position	Elevation
7:29 p.m.	222°	20°
7:30	204	27
7:31	176	31
7:32	149	27

Vanishes into Earth's shadow

Tiangong-2, 10 February 2019

Time	Position	Elevation
6:33 p.m.	250°	10°
6:37	334	70
6:40	60	10

ISS, 10 February 2019

Time	Position	Elevation
6:27 p.m.	326°	21°
6:28	341	37
6:29	38	57
6:30	99	38
6:31	114	21

HST, 10 February 2019

Time	Position	Elevation
7:19 p.m.	226°	21°
7:20	207	28
7:21	179	32
7:22	151	28
7:23	132	21

HST, 11 February 2019

Time	Position	Elevation
7:08 p.m.	228°	20°
7:09	210	27
7:10	182	32
7:11	154	28
7:12	135	21

HST, 12 February 2019

Time	Position	Elevation
6:57 p.m.	230°	20°
6:58	211	27
6:59	183	31
7:00	156	27
7:01	137	20

Key: Position is measured in degrees clockwise from north. That is, 0° is due north, 90° is due east, 180° is due south, and 270° is due west. Your fist held at arm's length is about ten degrees wide. "Elevation" is elevation above the horizon in degrees. Thus, to see the Hubble Space Telescope at 6:57 p.m. on February 12, measure five fist-widths west from due south, then two fist-widths above the horizon.

All times are rounded off to the nearest minute except for times when the satellite enters or leaves the shadow of the Earth. The highest elevation shown for each viewing opportunity is the actual maximum elevation for that appearance.

Programming Notice: NASA TV on the Web

Watch NASA TV (Public, Media and Education Channels) on your computer using Flash, Windows or QuickTime at <http://www.nasa.gov/multimedia/nasatv/index.html>.

NASA TV Schedules are available at <http://www.nasa.gov/multimedia/nasatv/schedule.html>
There don't seem to be any substantial live events for January.

Calendar of Events

- First quarter of 2019: First launch of LauncherOne, Virgin Orbit's two-stage orbital vehicle.
- January 11: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.
- January 12: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.
- January 17: Launch of the uncrewed Commercial Crew SpaceX Demonstration mission to the ISS. This tests the capsule which will eventually carry people to the ISS.
- January 20: Total Eclipse of the Moon, visible throughout the Americas. Totality is 10:41 p.m. – 12:44 a.m. CST. [See "Space News" above]
- January 29: Mercury is in superior conjunction with the Sun.
- February or March: Projected date that India's *Chandrayaan-2* may be launched to the Moon. The mission includes a lander, rover and orbiter, the first two landing near the south pole of the Moon. For more information, see <https://en.wikipedia.org/wiki/Chandrayaan-2>.
- February 8: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.
- February 9: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.
- February 12: Uranus is 1.0 degrees southeast of Mars.
- February 13: Launch of *Beresheet* ("Genesis," formerly known as *Sparrow*), the first Israeli moon lander.
- February 18: Saturn is 1.1 degrees to the lower right of Venus.
- February 26: Mercury is at greatest eastern elongation, 18 degrees from the Sun (hence is visible after sunset.)
- February 28: Launch of Expedition 59 to the ISS.
- March: Third launch of Falcon Heavy, this on the Space Test Program Flight 2 for the Air Force. This will carry 25 small satellites and a 5000 kg ballast mast which presumably will not be a Tesla Roadster.
- March: Boeing's CST-Starliner makes an automated uncrewed flight to the ISS.
- March 3 – 13: 50th anniversary of *Apollo 9*, the first test of the Lunar Module (in Earth orbit).
- March 6: Neptune is in conjunction with the Sun.
- March 8: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.
- March 9: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.
- March 14: Mercury is at inferior solar conjunction.
- April 10: Neptune is 0.4 degrees northwest of Venus.
- April 11: Mercury is at greatest western elongation, 27 degrees west of the Sun (hence is visible before sunrise). This is a poor elongation due to the shallow angle of the ecliptic with respect to the horizon.
- April 12: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.
- April 12: Yuri's Night: 58th anniversary of orbital manned space flight.
- April 13: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.
- April 22-23: Peak of Lyrid meteor shower.
- May 5: Peak of the Eta Aquariid meteor shower.
- May 10: Oklahoma City Astronomy Club meets at Science Museum Oklahoma (formerly the Omniplex). 7:00 p.m., followed by a talk at about 7:45 p.m. See <http://www.okcastroclub.com/> for details.
- May 11: [Tentative] Oklahoma Space Alliance meeting, 2:00 p.m., location to be announced.
- May 18 – 26: 50th anniversary of *Apollo 10*, the second manned mission to orbit the Moon, and the first to test the Lunar Module in Moon orbit. Astronauts were Tom Stafford, John Young and Eugene Cernan.
- June: SpaceX will carry a crew of NASA astronauts to the ISS. If this happens as scheduled, this will be the first American spacecraft to carry astronauts to orbit since 2011, but note that this has been postponed several times.
- June 7: Peak of the Arietid meteor shower.
- June 9: Jupiter is at opposition.
- June 18: Mars is 0.3 degrees below Mercury.
- June 23: Mercury is at greatest eastern elongation, 25 degrees from the Sun (hence is visible after sunset.)
- July 2: Total eclipse of the Sun visible from South Pacific including Pitcairn Island, Chile and Argentina.
- July 8: Saturn is at opposition.

July 20: 50th Anniversary of *Apollo 11* landing on the Moon.

July 24: Soyuz MS-13 launches to the ISS. This is the last Soyuz seat contracted by NASA.

August: Boeing's CST-Starliner makes its first crewed flight. See https://en.wikipedia.org/wiki/CST-100_Starliner for details.

August 10: Mercury is at greatest western elongation, 19 degrees from the Sun (hence is visible before sunrise.)

August 12: Peak of the Perseid meteor shower.

August 13: Venus is at superior conjunction with the Sun.

Fall 2019: ALINA, the *Autonomous Landing and Navigation Module* will be launched aboard a Falcon Block 5, and land near the *Apollo 17* landing site in the Taurus-Littrow valley. It will carry two Audi lunar rovers which will try to locate *Apollo 17*'s Lunar Rover. For more information, see <https://ptscientists.com/products/alina>.

September: Arrival of *OSIRIS-REx* at the near-earth asteroid 101955 Bennu to return samples. For more information, visit <http://en.wikipedia.org/wiki/OSIRIS-REx> or <http://science.nasa.gov/missions/osiris-rex/>.

September 9: Neptune is at opposition.

October 2: First operational mission of Dragon 2 to the ISS.

October 15: Launch of *CHEOPS*, the European Space Agency's exoplanet studier, from Kourou, French Guiana by a Soyuz rocket.

October 19: Mercury is at greatest eastern elongation, 25 degrees from the Sun (hence is visible after sunset.)

November 11: Mercury transits the Sun. The transit pretty much lasts all morning.

November 28: Mercury is at greatest western elongation, 20 degrees from the Sun (hence is visible before sunrise.)

December: Launch of China's *Chang'e 5* lunar sample return mission. This will be the first such mission since 1976.

December 14: Peak of the Geminid meteor shower.

December 26: Annular solar eclipse visible in Saudi Arabia, Qatar, India, Sri Lanka, Indonesia, the Philippines and Guam.

Sometime in 2020 Launch of the European Space Agency's Euclid space telescope. This will map the distribution of dark matter and search for evidence of dark energy. The Euclid website is <http://sci.esa.int/euclid>.

Sometime in 2020: Launch of the Korea Pathfinder Lunar Orbiter by SpaceX. This will be South Korea's first lunar mission and will also include an impactor.

February 2020: Launch from Cape Canaveral of the European Space Agency/NASA Solar Orbiter (SolO), which will orbit the Sun at a distance closer than Mercury. Not to be confused with NASA's *Parker Solar Probe*. Web site is sci.esa.int/solarorbiter

March 24, 2020: Venus is in greatest eastern elongation, 46 degrees from the Sun (hence is visible after sunset.)

June 2020: [Moved from 2019] Maiden flight of the Space Launch System.

June 2020: NASA launches the Lunar IceCube, Lunar Polar Hydrogen Mapper, and Lunar Flashlight lunar orbiters. For more information, see https://en.wikipedia.org/wiki/Lunar_IceCube.

July 2020: United Arab Emirates launch the Mars probe *Hope*, aka as *Al-Amal* or the *Emirates Mars Mission*, from the Mohammed bin Rashid Space Center in Dubai. For more information, visit https://en.wikipedia.org/wiki/Hope_Mars_Mission.

July 2020: Launch of the *Mars 2020* space rover, which will arrive on Mars at the beginning of 2021. For more information, see https://en.wikipedia.org/wiki/Mars_2020 or <https://mars.jpl.nasa.gov/mars2020/>.

July 23, 2020: Launch of the Mars Global Remote Sensing Orbiter, Lander and Small Rover by China. For more information, see https://en.wikipedia.org/wiki/Mars_Global_Remote_Sensing_Orbiter_and_Small_Rover. (China really needs to work out an acronym for this.)

July 25, 2020: ESA launches the *ExoMars Mars Rover* For more information, visit en.wikipedia.org/wiki/Exomars.

August 13, 2020: Venus is in greatest western elongation 45 degrees from the Sun (hence is visible before sunrise.)

October 13, 2020: Mars is at opposition, 39 million miles from Earth.

December 2020: Launch of the Korea Pathfinder Lunar Orbiter (KPLO) and lunar impactor from Naro Space Center in South Korea.

Sometime in 2021: *Hope*, aka *Emirates Mars Mission*, arrives at Mars (see July 2010).

Sometime in 2021: India hopes to launch its first manned spaceflight, but 2024 is more likely.

March 30, 2021: [Moved yet again]: Launch of the James Webb Space Telescope.

October 29, 2021: Venus is in greatest eastern elongation 47 degrees from the Sun (hence is visible after sunset.)

Sometime in 2022: SpaceX plans to launch a human crew around the Moon. [This is speculative, reflected by this mission being postponed from 2018.]

Sometime in 2022: Proposed launch date of JUICE, the Jupiter Icy Moon Explorer, by the European Space Agency. The JUICE web site is <http://sci.esa.int/juice>.

June 2022: First crewed launch of an *Orion* space capsule.

Sometime in 2023: *OSIRIS-REx* returns with samples from the Asteroid Benu.

April 8, 2024: Next total eclipse of the Sun visible in the United States. This one will be visible on a path through northern Mexico (making landfall opposite the tip of Baja California), passes through Texas (including Dallas, Arlington and Waco), touches the southeastern corner of Oklahoma, then crosses Arkansas, eastern Missouri, Illinois, western Kentucky, Indiana, Ohio (including Cleveland), Erie in Pennsylvania, upper New York (including Buffalo and Niagara Falls), Burlington in Vermont, New Hampshire, and Maine, then into Canada.

December 19, 2024: *Parker Solar Probe* (formerly *Solar Probe Plus*) makes its first pass through the outer corona of the Sun. For more information, see <http://parkersolarprobe.jhuapl.edu>.

December 2025: *BepiColombo* arrives at Mercury orbit.

Sometime in 2030: JUICE achieves Jupiter orbit. [See 2022.]

Sometime in 2033: JUICE achieves Ganymede orbit. [See 2022.]

August 12, 2045: The next total solar eclipse visible in Oklahoma City. This one is also visible in Salt Lake City, Denver, Little Rock (again), Tampa Bay and New Orleans.

Oklahoma Space Alliance Officers, 2019 (Area Code 405)

Clifford McMurray, President & <i>Update</i> Editor	329-4326 (H) 863-6173 (C)
Dave Sheely, Vice-President	821-9077 (C)
Syd Henderson, Secretary & <i>Outreach</i> Editor	321-4027 (H) 365-8983 (C)
Tim Scott, Treasurer	740-7549 (H)
Claire McMurray, Communications	329-4326 (H) 863-6173 (C)

OSA E-mail Addresses and Web Site:

cliffclaire at hotmail.com (Claire & Clifford McMurray)
 sheely at sbcglobal.net or david.sheely.1 at us.af.mil (David Sheely)
 sydh at ou.edu (Syd Henderson)
 sswift42 at aol.com (Steve Swift)
 ctscott at mac.com (Tim Scott)
 t_koszoru01 at cox.net (Heidi and Tom Koszoru, new address)
 john.d.northcutt1 at tds.net (John Northcutt)
 lensman13 at aol.com (Steve Galpin)

E-mail for OSA should be sent to sydh@ou.edu. Members who wish their e-mail addresses printed in *Outreach*, and people wishing space-related materials e-mailed to them should contact Syd. Oklahoma Space Alliance website is osa.nss.org. Webmaster is Syd Henderson.

Other Information

Oklahoma Space Industrial Development Authority (OSIDA), 401 Sooner Drive/PO Box 689, Burns Flat, OK 73624, 580-562-3500. Website is <http://airspaceportok.com/#home>,

Science Museum Oklahoma (former Omniplex) website is www.sciencemuseumok.org. Main number is 602-6664.

Tulsa Air and Space Museum, 7130 E. Apache, Tulsa, OK 74115.

Web Site is www.tulsaairandspacemuseum.com. Phone (918) 834-9900.

The Mars Society address is Mars Society, Box 273, Indian Hills CO 80454. Their web address is www.marsociety.org.

The National Space Society's Headquarters phone is 202-429-1600. Executive Director e-mail nsshq@nss.org. The Chapters Coordinator is Bennett Rutledge 720-641-7987, rutledges@chapters.nss.org. The address is: National Space Society, PO Box 98106, Washington DC 20090-1600 Web page is www.nss.org.

The Planetary Society phone 626-793-5100. The address is 65 North Catalina, Avenue, Pasadena, California, 91106-2301 and the website is www.planetary.org. E-mail is tps@planetary.org.

NASA Spacelink BBS 205-895-0028. Or try www.nasa.gov.

Congressional Switchboard 202/224-3121.

Write to any U. S. Senator or Representative at [name]/ Washington DC, 20510 (Senate) or 20515 [House]

OKLAHOMA SPACE ALLIANCE
A Chapter of the National Space Society
MEMBERSHIP ORDER FORM

Please enroll me as a member of Oklahoma Space Alliance. Enclosed is:

_____ \$10.00 for Membership. (This allows full voting privileges, but covers only your own newsletter expense.)

_____ \$15.00 for family membership

_____ TOTAL amount enclosed

National Space Society has a special \$20 introductory rate for new members. Regular membership rates are \$52, Student memberships are \$36, Senior \$42. Part of the cost is for the magazine, *Ad Astra*. If you choose to receive the magazine digitally, memberships are \$40 for regular, \$24 for students and \$30 for seniors. Mail to: National Space Society, PO Box 98106, Washington, DC 20090, or join at www.nss.org/membership. (Brochures are at the bottom with the special rate.) Be sure to ask them to credit your membership to Oklahoma Space Alliance.

To join the Mars Society, visit www.marssociety.org. One-year memberships are \$50.00; student and senior memberships are \$25, and Family memberships are \$100.00. Their address is Mars Society, 11111 W. 8th Ave, Unit A, Lakewood, CO 80215.

Do you want to be on the Political Action Network?

_____ Yes_____ No. [See brochure for information.]

Name_____

Address_____

City_____ State___ ZIP_____

Phone (optional or if on phone tree)_____

E-mail address (optional)_____

OSA Memberships are for 1 year, and include a subscription to our monthly newsletters, *Outreach* and *Update*. Send check & form to **Oklahoma Space Alliance, 102 W. Linn, #1, Norman, OK 73071.**